

# Introduction to the Issue on Fiber Lasers

**W**ELCOME to the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS (JSTQE) Issue on Fiber Lasers. Fiber lasers is an advanced field of modern science entering in all branches of science. This field continues to vastly expand with state-of-the-art developments across the entire spectrum of scientific, military, medical, industrial, and commercial applications ranging from spectroscopy to material cutting, welding, and marking.

The field of lasers has a relatively short history starting from 1960 with Maiman's first demonstration of laser action in ruby followed by first fiber laser demonstration by Snitzer in 1961. The recent explosive development and applications of the physics and technology of fiber lasers greatly stimulate new advanced research areas including generation of ultrashort and high-energy pulses. Researchers in the area of material science are continuously trying to develop new composition-based doping host for improving the lasing efficiency with low photodarkening phenomena which is vital for high-power laser. At the same time, researchers are also striving to develop new kind of fiber laser sources at near-infrared region (NIR) beyond  $2.0\text{ }\mu\text{m}$ , which is very much useful for biomedical applications. At present, optical fiber materials with ultrabroadband gain in the NIR, 1100–1500 nm, are of great interest for the development of compact, versatile, and high brightness light sources in the low-loss transmission window of silica fiber, where no efficient active fiber exists. Applications for such a source are diverse, including communications in the 1300–1500-nm region, OCT for imaging, generation of efficient yellow light by frequency doubling for dermatological, and laser guide star use. Existing sources in this wavelength range have either limited bandwidth or limited efficiency. In particular, rare earth (RE) doped glasses are generally limited to 100-nm bandwidth in the NIR, and the available RE transitions do not span 1150–1500 nm with high efficiency. To solve this problem, a new kind of bismuth doped fiber laser is recently developed. On the other hand, laser researchers are continuously working to generate shorter laser pulses, which have become increasingly important in a wide range of scientific, technological, medical, and other applications. The main problems associated with the generation of shorter pulses are a relatively high dispersion and nonlinearity of fiber resonator, where the effects of dispersion can be compensated by different approaches. The nonlinearity plays a critical role in the design of advanced fiber laser systems through substantial efforts made to reduce the resonator nonlinearity by using large-mode-area fibers. This direction presents an important modern trend in laser technology. On the other hand, understanding and mastering nonlinear physical fiber systems offer the potential to enable a new generation of laser concepts. Therefore, it is of great importance to study physics and engineering design of laser systems based on nonlinear

photonic technologies. In particular, new nonlinear approaches and solutions shall pave the way for the development of advanced mode-locked fiber lasers with ultrashort high-energy pulses.

The objective of this JSTQE Issue on Fiber Lasers is to highlight recent progress and trends in fiber laser technology. The papers published in this issue cover a broad range of advanced fiber laser areas summarized in the following sections:

- 1) Fiber lasers.
- 2) Mode-locked lasers.
- 3) Optical amplifier science.
- 4) Optical amplifier technology.
- 5) Optical waveguide.
- 6) Fiber based sensors.
- 7) Optical signal processing and frequency conversion technology.
- 8) Industrial applications.

These key research topics are highlighted as comprehensive overviews of the current status and future trends as well as original results and recent developments in the field of fiber lasers. This issue contains 74 papers, including 19 invited and 55 contributed papers authored by well-established research groups and promising scientists from all over the world. The invited papers include performance scaling of ultrafast laser systems by coherent addition of femtosecond pulses, applications of fiber lasers for the development of compact photonic devices, carbon-nanotube-based nonlinear fiber devices for fiber lasers, bidoped optical fibers and fiber lasers, dual-wavelength fiber lasers for the optical generation of microwave and terahertz radiation, development of eye-safe fiber lasers near  $2\text{ }\mu\text{m}$ , mid-IR ultrashort pulsed fiber-based lasers, high-power fiber lasers, high-power thulium-doped all-fiber superfluorescent sources, fiber femtosecond pulse amplification techniques, and their applications. The contributed papers cover a broad variety of key fiber laser research areas including recently obtained original results on mode-locked fiber laser, optical amplifier technology, optical waveguide, fiber based sensors, and optical signal processing technology.

We hope you will find this JSTQE Issue on Fiber Lasers to be an interesting and useful reference that will impact, stimulate, and promote further advances in the area of fiber lasers.

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ANDREY S. KURKOV, *Guest Editor*  
Russian Academy of Science  
Moscow, Russia

SULAIMAN WADI HARUN, *Primary Guest Editor*  
Department of Electrical Engineering  
Faculty of Engineering  
University of Malaya  
50603 Kuala Lumpur, Malaysia

MUKUL CHANDRA PAUL, *Guest Editor*  
Fiber Optics and Photonics Division  
CSIR-Central Glass and Ceramic  
Research Institute  
Jadavpur, Kolkata-32, India

SHAIF-UL ALAM, *Guest Editor*  
University of Southampton  
Highfield, Southampton, Hampshire  
SO17 1BJ, U.K.

ZHIPEI SUN, *Guest Editor*  
Department of Micro- and Nanosciences  
Aalto University  
Espoo 02150, Finland



**Sulaiman Wadi Harun** received the B.E. degree in electrical and electronics system engineering from the Nagaoka University of Technology, Nagaoka, Japan, in 1996, and the M.Sc. and Ph.D. degrees in photonic technology from the University of Malaya, Kuala Lumpur, Malaysia, in 2001 and 2004, respectively. Since 2010, he has been a Full Professor with the Department of Electrical Engineering, University of Malaya. His current research interests include the development of various optical fiber devices including fiber amplifiers, fiber lasers, and fiber-optic sensors. He has published more than 450 papers in ISI journals and his papers have been cited more than 2200 times with an h-index of 25. He has successfully supervised 25 Ph.D. students in these topics to completion.



**Shaif-ul Alam** received the Ph.D. degree from the University of Southampton, Southampton, U.K., in 2001, where he is currently a Principal Research Fellow with the Optoelectronics Research Centre. Between 2001 and 2008, he was with SPI Lasers (U.K.) Limited and Quantronix Corporation, USA, and successfully led numerous high-power fiber laser product development projects. His current research interests include fiber amplifier technology and applications of high-power, short-pulse fiber lasers. He has published more than 150 articles in international scientific journals/conferences. He received the prestigious Commonwealth Scholarship and JSPS Fellowship. He is a Senior Member of the Optical Society of America.



**Andrey S. Kurkov** was born in Norilsk, USSR, in 1957. He received the Graduate degree from the Physical Department, Moscow State University, Moscow, Russia, in 1980, the Ph.D. degree in GPI, and Dr.Sc. degree in 1989 and 2003, respectively. Since 1983, he has been with General Physics Institute. He is also the Head of the Photonic Laboratory, Perm Scientific Center RAS. His main fields of research interests include fiber lasers and amplifiers, special fibers, and fiber sensors. He has published more than 300 papers in scientific journals and international conferences and his papers have been cited more than 1400 times with an h-index of 24. He is the Member of the Editorial Board of *Laser Physics* and *Laser Physics Letter* and the Chair of Program Committee of the Russian Fiber Laser Seminar.



**Mukul Chandra Paul** received the M.Sc. (Hons.) degree in inorganic chemistry from the University of Burdwan, Bardhaman, India, and the Ph.D. degree in fiber optics from the Jadavpur University, Kolkata, India, in 2003. He is currently a Principal Scientist with the Fiber Optics and Photonics Division, Central Glass and Ceramic Research Institute, Kolkata, India, where he has been a Scientist since 1997. He has published more than 150 papers in peer-reviewed journals and conferences. He also published seven book chapters. He holds seven U.S. patents and filed four Indian patents. He is involved with several collaborative projects with different countries such as U.K., Mexico, Malaysia, etc. His research interests include the area of special optical fiber for fiber lasers, optical amplifiers, and sensors. He has received a number of prestigious awards including the Young Scientist Award under the U.K.-India Networking Research Program in 2003, BOYSCAST Fellowship from the Department of Science and Technology in 2005, CSIR Technology Award in 2012, and DST-UKIERI Award in 2013. He is a Member of the Optical Society of America, American Chemical Society, and Life Member of the Materials Research

Society of India and the Indian Ceramic Society. He is an Editorial Board Member of the *New Journal of Glass and Ceramics*, the *International Journal of Advanced Nanomaterials*, the *International Journal of Materials Science Research*, and the *Journal of Materials Science and Engineering Progress*.



**Zhipei Sun** received the Ph.D. degree from the Institute of Physics, Chinese Academy of Sciences, Beijing, China. From 2005 to 2007, he worked as a Research Fellow with ICFO—The Institute of Photonic Sciences, Barcelona, Spain. In 2007, he joined the Department of Engineering, Cambridge University, U.K., where he worked as Senior Research Associate. Since 2012, he has been an Associate Professor and a Group Leader with the Department of Micro- and Nanosciences, Aalto University, Espoo, Finland. He is an Academy Research Fellow, Academy of Finland, Helsinki, Finland. His current research interests include nanomaterials (e.g., carbon nanotubes, graphene, and other two-dimensional materials) fabrication, integration, characterization for applications in photonics, and optoelectronics (e.g., ultrafast fiber lasers).